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TAXONOMIC REVISION OF THE POLYPODIACEOUS GENERA OF INDIA-IV *POLYPODIUM LINEARE* COMPLEX AND ALLIED SPECIES

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ABSTRACT

The Asiatic genus *Lepisorus* (J. Smith) Ching consists of about 25 species, majority of which are known from the Sino-Himalayan region. The present paper deals with the taxonomy of *Lepisorus* species which belong to *Polypodium lineare* complex. Our studies have revealed that the Himalayan and South Indian material generally placed under *P. lineare* is a collection of large and variable types and this material has been sorted out into *L. nudus* (Hook.) Ching, *L. amaurolepida* (Sledge) Bir & Trikha, *L. bicolor* Ching, *L. pseudonudus* Ching, *L. angustus* Ching, *L. ussuriensis* (Regel & Maack) Ching, *L. contortus* Ching and *L. thunbergianus* (Kaulf.) Ching. Out of these *L. ussuriensis*, *L. contortus* and *L. bicolor* are new records from the Indian region. Several of these species are sympatric in distribution and are closely allied in the form of the laminae. These are separable mainly on the basis of the outline and structure of scales and spores.

INTRODUCTION

The present paper is a continuation of the earlier work of the authors (*Bir & Trikha*, 1968) on the taxonomy of *Pleopeltis* Humb. & Bonpl. ex Willd. and *Lepisorus* (J. Smith) Ching wherein, a justification for keeping these two as distinct genera as far as the Indian species are concerned, was advanced and two species of *Pleopeltis*, namely, *P. macrosphaera* (Bak.) Panigr. & Patn. and *P. macrocarpa* (Bory ex Willd.) Kaulf. from India were described and illustrated. The rest of the Indian species usually placed under *Pleopeltis* following Copeland (1947) by Panigrahi & Patnaik (1964, 1965), belong to *Lepisorus*.

The genus *Lepisorus* was re-established in 1933 and 1940 by Ching and is based on *L. thunbergianus* (Kaulf.) Ching. It consists of about 25 Asiatic species, majority of which are known from the Sino-Himalayan region. Only one species, *L. longifolius* (Bl.) Holtt. is met with throughout Malaysia. Taxonomically it is a difficult genus. Most of the species are similar-looking and are feebly distinguished. These can, however, be separated on a detailed examination of the rhizome scales and spores. Frequently specimens belonging to quite a different number of species of the genus have been described under *Polypodium lineare* Thunberg by earlier workers.

Taxonomy of the majority of the Indian species of *Lepisorus* at present is rather in a state of confusion. The main purpose of the present paper, therefore, is to clarify the taxonomic confusion centering around the Indian representatives generally referable to *Polypodium lineare* complex or allied species. The observations of the authors are largely based on the study of representative collections drawn from various Indian herbaria and U.S. National Herbarium, Washington.

TAXONOMY

Lepisorus [J. Smith in Bot. Mag. 72: (Camp) 13.1846; Hist. Fil. 13.1875 as section] Ching in Bull. Fan Mém. Inst. Biol. 4: 47.1933; C. Chr., in Verdoorn's "*Manual of Pteridology.*" P. 547. 1938.

Rhizome widely creeping or sometime rather short, often branched, bearing two rows of fronds articulated to it, paleaceous; scales invariably clathrate, the middle part firm and generally opaque; stipes closely or distantly placed, short; laminae uniform, simple, with entire margin, *both surfaces usually naked except for few scales along the midrib* or elsewhere, membranaceous to coriaceous; veins evident or immersed, forming a series of irregular areolae with many free included veinlets pointing in different directions, main lateral veins absent; sori round, elliptical or elongated, in a single row on either side of the midrib, large, sometime prominent on the upper surface, protected in young stage by numerous umbrella-shaped, clathrate paraphyses; spores bilateral, nonperisporiate, smooth or nearly so.

Lepisorus shares the presence of umbrella-shaped paraphyses with *Pleopeltis, Lemmaphyllum, Hymenolepis, Microsorium normale* and *M. phyllomanes*, the last fern is often placed under the genus

Neocheiropteris. Of these, *Lemmaphyllum* is nearly allied to *Lepisorus* but differs in having linear sori and dimorphic fronds, the fertile ones being narrower and longer. The outline of the frond and the arrangement of sori is also shared with few species of *Phymatodes*, but the members of the two genera, namely *Lepisorus* and *Phymatodes*, are separated by the fact that in the latter genus the sporangial paraphyses are never umbrella-shaped but are only hair-like or club-shaped and elongated and also the main lateral veins are prominent.

Out of about 13 Indian species of *Lepisorus* at least three species, namely *L. clathratus* (Clarke) Ching, *L. nudus* (Hook.) Ching and *L. kashyapii* (Mehra) Mehra are quite widely distributed throughout the Himalayas from Kulu to Darjeeling. *L. kashyapii* is endemic in the Himalayas.

The present studies have revealed that the South Indian and the Himalayan material of *Polypodium lineare* of authors, present in the Indian herbaria is a collection of large and variable types and not a single species. This material has been sorted out into *L. nudus* (Hook.) Ching, *L. amaurolepida* (Sledge) Bir & Trikha, *L. bicolor* Ching, *L. pseudonudus* Ching, *L. angustus* Ching, *L. ussuriensis* (Regel & Maack) Ching, *L. contortus* (Christ) Ching and *L. thunbergianus* (Kaulf.) Ching. Of these, *L. ussuriensis*, *L. contortus* and *L. bicolor* are new records from the Indian region. All the species are feebly distinguished and several of these are sympatric in distribution. Darjeeling and Sikkim Himalayan specimens of *L. scolopendrius* (Don) Mehra & Bir have been found to represent the morphology somewhat intermediate between *L. excavatus* (Bory) Ching and *L. kashyapii* (Mehra) Mehra. These do not have well-marked spore and scale characters that are different from *L. kashyapii* but the lamina is with characteristic shape. It is more elongated and narrower. Also the rhizome is superficial and is well above the substratum by means of long wiry roots as is the case in *L. kashyapii*. We have excluded this species from the present account pending the availability of authenticated specimens and study of more herbarium material.

Majority of the Indian members of the genus in the Himalayas and South India grow either epiphytically or on rocks between 900-4,200 m altitude together with *Araiostegia pseudocystopteris* (Kunze) Copel. and *Polypodium microrhizoma* Clarke ex Bak. These frequently cover large portions of tree trunks and branches at about 2,100 m altitude in the Himalayas.

KEY TO THE SPECIES

- A. Sori near the margin (submarginal), round or oblong ... ... 1. *L. loriformis*
- A. Sori medial in position or near the midrib, round:
  - B. Rhizome thin (upto 4 mm thick), fronds linear or linear-lanceolate, narrow, never more than 2 cm wide:
    - C. Texture membranaceous ... 2. *L. clathratus*
    - C. Texture coriaceous:
      - D. Scales ovate, acute with almost smooth margin, cell luminae clear ... ... 3. *L. nudus*
      - D. Scales ovate, shortly acuminate with orbicular base, and prominent dentate margin, bicolorous, thickened in the middle, cell luminae opaque ... 4. *L. amaurolepida*
      - D. Scales ovate-lanceolate, acuminate with rounded base and prominent protruding distant marginal teeth, fuscous, concolorous, cell luminae throughout uniform and clear ... ... 5. *L. pseudonudus*
      - D. Scales atratous, rigid, opaque:
        - E. Scales ovate acuminate, margin of the scale never hyaline, apex long attenuate, spores tuberculated ... 6. *L. ussuriensis*
        - E. Scales linear or lanceolate, subulate, with broadly ovate base, margin of the base hyaline and thin walled:
          - F. Fronds about 1/2 cm wide, caudato-attenuate apex, sori elongate, spore verrucose granulated ... 7. *L. angustus*
          - F. Fronds at least 1 cm wide, apex not attenuate, sori round and spore tuberculated ... 8. *L. thunbergianus*
      - D. Scales rufo-brown, cells luminae elongated and clear except central ones; spores smooth ... 9. *L. contortus*
  - B. Rhizome thick (more than 4 mm in diameter); fronds always more than 2 cm wide: ... ...
    - C. Venation distinct; texture herbaceous:
      - D. Sori punctate, fronds upto 3 cm (rarely up to 4 cm) wide:
        - E. Lateral veins inconspicuous; fronds turn bright brown on drying; scales under midrib hair-pointed ... 10. *L. kashyapii*
        - E. Lateral veins prominent; fronds pale or greenish on drying and scales along lower midrib never hair-pointed ... ... 11. *L. excavatus*
      - D. Sori not punctate on upper surface; fronds more than 3 cm wide (upto 8 cm) ... 12. *L. kuchenensis*
  - B. Rhizome thick (more than 4 mm in diameter); fronds never more than 2 cm wide; rhizome scales broadly ovate, short acuminate, bicolorous; frond scales with erose margin; venation obscure and texture coriaceous ... 13. *L. bicolor*

Lepisorus loriformis (Wall. ex Mett.) Ching in Bull. Fan Mém Inst. Biol. 4: 81. 1933; Ic. Fil. Sin. 2: Pl. 61. 1934, cum syn.: Mehra & Bir in Res. Bull. Panjab Univ. (n.s.), 15: 169. 1964.

Polypodium loriforme Wall. (List. n. 271. 1828, *nomen nudum*) ex Mett., Uber Farngatt. 1: 92. 1857 (=Abhandl. Senckenb. Naturf. Ges.. 2: 92. 1857); C. Chr., in Contr. U.S. Herb. 20: 217. 1931.

Pleopeltis linearis sensu Bedd., Handb. Ferns Brit. India 346, 1883 (pro parte).

P. loriformis (Wall.) Moore, Index Fil. 346. 1882; Alston & Bonner in Candollea 15: 208. 1956.

Polypodium lineare var. *stensite* Clarke in Trans. Linn. Soc. Lond. II. Bot. 1: 559. 1880.

P. excavatum var. *loriforme* C. Chr., Index Fil. 541. 1906.

P. lineare var. *loriforme* Takeda in Notes. R. Bot. Gard. Edinb. 8: 275. 1915.

Rhizome short-creeping thin upto 1.5-2.5 mm in diameter, densely scaly; scales ovate, long-acuminate, denticulate, coarsely clathrate, fuscous, with large clear uniform hexagonal luminae, concolorous, upto 4 mm long and 1 mm wide at base; stipes short, 1-3 cm long, rather approximate; fronds 20-45 cm long and 0.4-1.5 cm wide, linear-elongate, gradually attenuate to a short stipe, apex long acuminate, margin generally entire or slightly repando-undulate, usually brown in colour, and with revoluted margin when dry; texture subcoriaceous; midrib prominent, lateral veins and veinlets completely immersed, slightly visible in fresh state; sori rounded or oblong, medium-sized, submarginal, usually 1 cm apart, when young densely covered with long stalked stellato-peltate paraphyses, along with are also present 2-7 celled hair-like and club-shaped simple paraphyses; annulus cells 11-15; spores yellow, reniform or plano-convex to concavo-convex or sometime oval, smooth, exine slightly thickened, fully packed with food material, 48-67 × 32-48 μ (Figs. 1, 4-8).

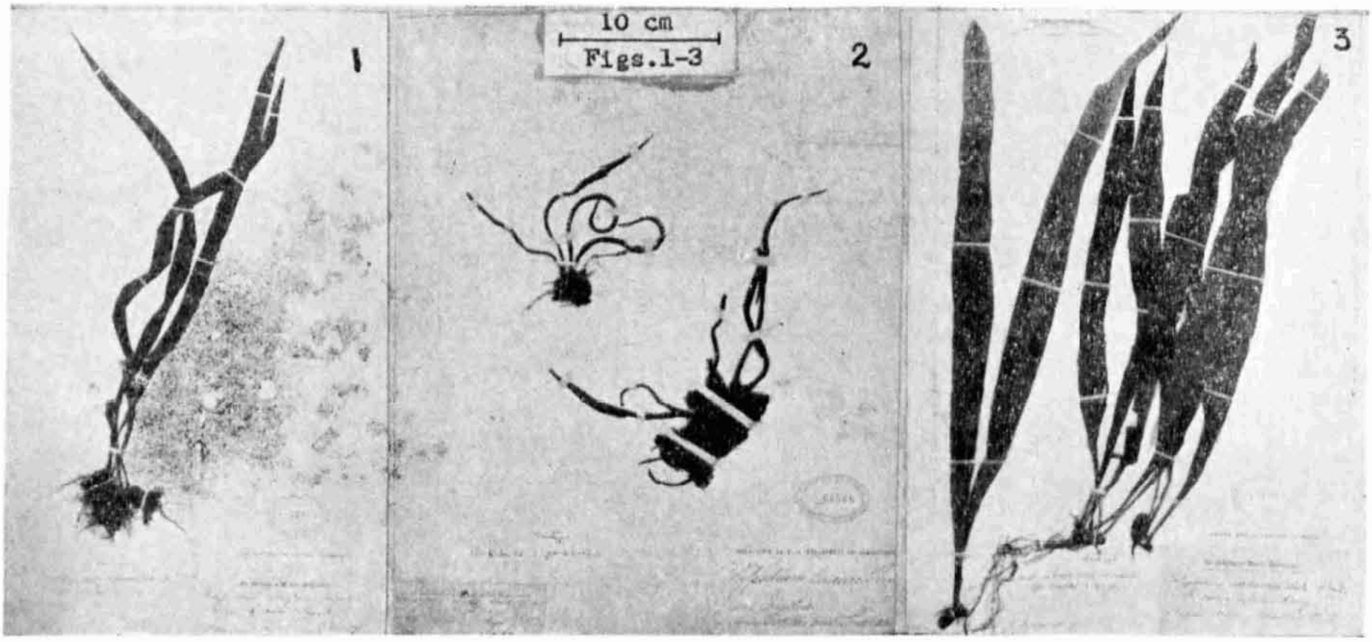

Plate 1 : Figs. 1-3 : Photographs of the Isotype specimens : 1. *Lepisorus loriformis* (Wall. ex Mett.) Ching (=*Polypodium loriforme* Wall. ex Mett., US 1277829). 2. *Lepisorus nudus* (Hook.) Ching (=*Pleopeltis nuda* Hook., US 62546). 3. *Lepisorus excavatus* (Bory) Ching (=*Polypodium excavatum* Bory, US 1277832).

It is a common epiphyte of forests around Darjeeling between 2,100-3,000 m altitude. Quite often grows as lithophyte. This fern is frequently found in the Eastern Himalayas, Nepal, Darjeeling, Sikkim State, extending throughout Assam between 1,500-3,000 m altitude.

Distribution: North India, Upper Burma and China (Yunnan).

L. loriformis is one of the most distinct species of the genus but unfortunately it had long been united with *Polypodium lineare* Thunb. by most of the Indian fern authors like C. B. Clarke, R. H. Beddome and J. G. Baker. It was only in 1915 that Takeda separated it from *Polypodium lineare* and raised it to a specific rank and was followed by Christensen (1931) who redescribed it in detail and concluded that it has hardly anything common with *P. lineare* Thunb. or *Polypodium excavatum* Bory.

This species is nearly allied to *Lepisorus longifolius* in its general habit, structure of scales on the rhizome and venation but it can easily be separated from *L. longifolius* by (i) linear-elongate fronds with subcoriaceous texture and brown colour in dry state, (ii) medium-sized, submarginal, sori covered with stellato-peltate paraphyses. In the other species *L. longifolius,* the sori are marginal but these are usually oblong or elongated and are deeply sunk in a cyst forming a corresponding elevated area on the upper surface.

*Specimens examined**: Isotype: *Polypodium loriforme* Wall. ex Mett. (Abhandl. Senckenb. Naturf. Ges. 2: 92. 1857) from Nepal, *Wallich* 271 in 1821 (US 1277829).

EASTERN HIMALAYAS: NEPAL: Between Samela and Dhaulakot (2,400 m), *Polunin, Sykes and Williams* 1867, April 1952 (US); Bhunjung near Ghanopokhara (1,950-2,250 m), *Stainton, Sykes and Williams* 5119, April 1954 (CAL); Lumsum, *Stainton, Sykes and Williams* 9147, 4923, 2719, April to Oct. 1954 (CAL). DARJEELING: Senchal lake (2,250 m), *Bir* 944, Aug. 1957 (PAN); Tonglu Road (2,400 m), *Bir* 792, July 1957 (PAN); 2,100 m, *Bir,* Aug. 1956 (PAN); *Malhotra,* Aug. 1954-55 (PAN); Tonglu Road, *Malhotra,* July 1957 (PAN); Senchal lake, *Bir,* Aug. 1957 (PAN). SIKKIM: Lachen (2,400 m), *Bir* 1048, July 1958 (PAN); 2,700 m, *Bir,* July 1958 (PAN); 2,550 m, *Bir* 1079, July 1958 (PAN); *Thomson* (US); Mahawarm (2,100 m), Nov. 1879 (CAL); *Gammie,* Oct. 1884 (CAL); *Gammie,* June 1892 (CAL); *Clarke,* Oct. 1810 (CAL); 2,100 m, *Gamble* 7288, Oct. 1879 (CAL); *King* 4007 in 1887 (CAL); Zemu Valley (2,700-3,600 m), *Smith & Cave* 2837, July 1909 (CAL); Mahawarm (2,100 m), *Blanford* 84, (CAL). ASSAM: 690 m, *Mann,* March 1887 (US); Bapa (1,440 m), *Burkill* 36539, Jan. 1912 (CAL); Khasya (1,350 m), *King* 169, March 1896 (CAL); Duphla Hills, *Lister,* Jan. 1875 (CAL); Shillong, *Levinge,* Nov. 1879 (CAL); Jowai Road, *Prain,* March 1892 (CAL); many sheets without specific collectoi and locality (CAL).

Lepisorus clathratus (Clarke) Ching in Bull. Fan Mém. Inst. Biol. 4: 71. 1933; Ic. Fil. Sin. 2: Pl. 67. 1934, cum syn.; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 169. 1964.

Polypodium clathratum Clarke in Trans. Linn. Soc. Lond. II. Bot. 1: 559. Pl. 82. fig. 1. 1880; Blanford in Jour. Asiatic Soc. Bengal, 57: 313. Pl. 21. 1888.

Pleopeltis clathrata (Clarke) Bedd., Handb. Ferns Brit. India 348, 1883; Alston & Bonner in Candollea 15: 208. 1956.

Rhizome widely creeping, thin, 2-4 mm in diameter, densely scaly, hypogaeous; scales ovate-lanceolate, acuminate, dark-brown to fuscous, thin, upto 5 × 1.5 mm, coarsely clathrate with large, uniform, isodiametrical luminae and with long protruding teeth on the margin; stines slender, pale, stramineous, .5-5.5 cm long, naked, closely placed (.5-1 cm apart); fronds linear-lanceolate, simple, 15-35 cm long, .5-1.5 cm broad, gradually attenuate to the base, leaf apex acuminate or obtuse, margin entire; texture thin, herbaceous; colour light-green, underside with few deciduous scales; venation distinct, no main lateral vein, areolae 1-3 from midrib to margin with free included veinlets; sori small to medium sized, of bright-orange colour, round, slightly oblong, covered in young stage with clathrate, umbrella-shaped sporangial paraphyses; annulus cells 10-15; spores light-yellow to hyaline in colour, reniform to plano-convex, concavo-convex or oval, exine thin, smooth, 36-74 × 21-48 μ (Figs. 9-12).

It is most widely distributed fern throughout the Himalayas between 1,500-3,600 m altitude from Kulu eastwards to Darjeeling and Sikkim State but more common in the Western part. The plants generally grow as epiphytes on the tree trunks but quite often these are found on the rocks also.

Distribution: Himalayas, Formosa and Japan.

This fern was previously known only from the Himalayas but has recently been recorded from Japan, Formosa and Continental Asia by Kurata (1965).

There is some variation as to the apex of the frond which may be obtuse or acutely pointed and also as to the presence of the scales on the frond. In Smila specimens few scales are present on the under surface of frond whereas in specimens from

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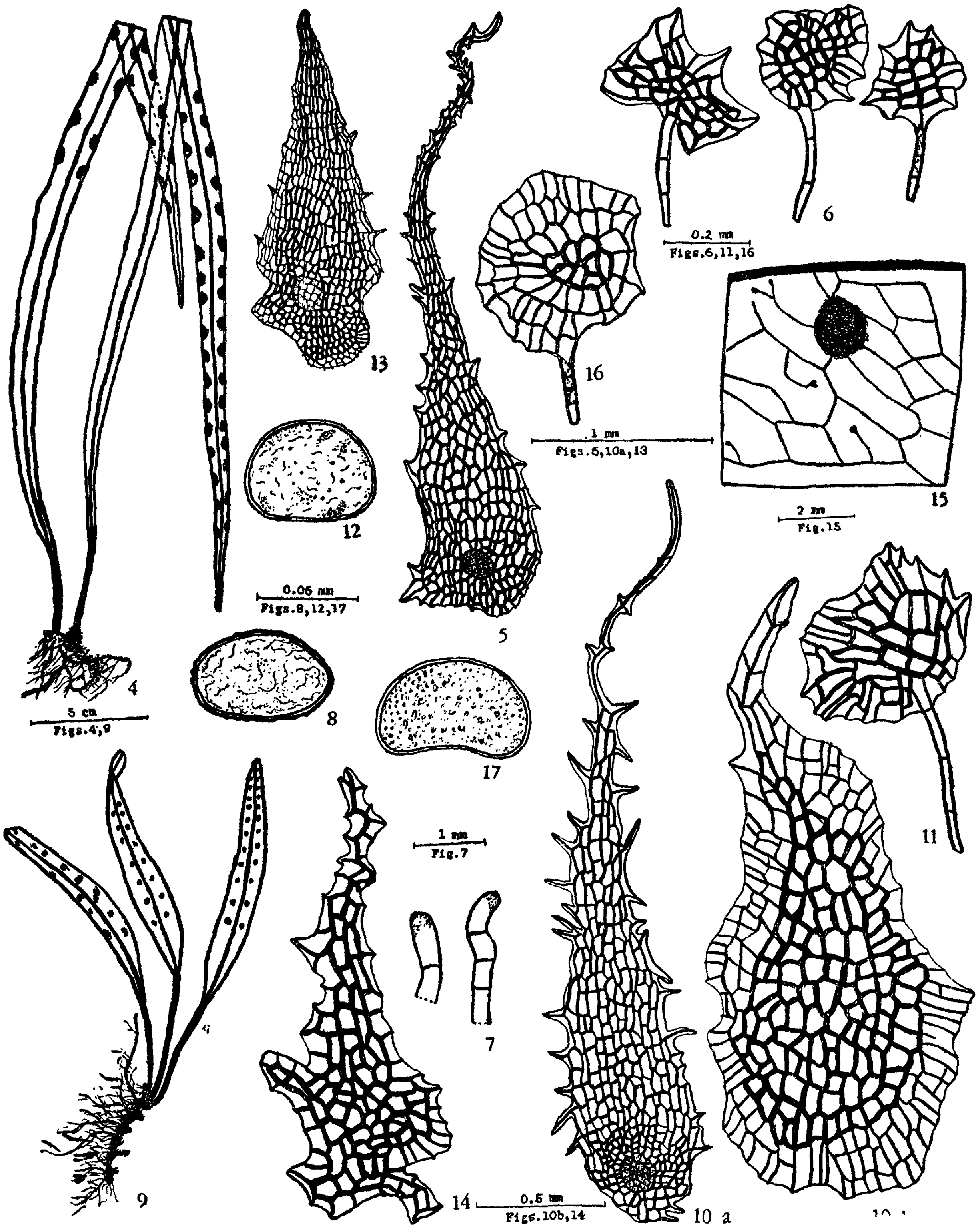
*The Panjab University Herbarium, Chandigarh (India) which is not yet included in "Index Herbarium", is here designated as PAN.



Figs. 4-8 : *Lepisorus loriformis* (Wall. ex Mett.) Ching : 4. Habit sketch. 5. Rhizome scale. 6. Sporangial paraphyses. 7. Hair-like sporangial paraphyses. 8. Spore. Figs. 9-12 : *Lepisorus clathratus* (Clarke) Ching : 9. Habit sketch. 10a. Rhizome scale. 10b. Frond scale. 11. Sporangial paraphyses. 12. Spore. Figs. 13-17 : *Lepisorus nudus* (Hook.) Ching: 13. Rhizome scale. 14. Frond scale. 15. Venation. 16. Sporangial paraphyses. 17. Spore.

other areas the lower surface is quite glabrous. In some of the Tehri-Garhwal specimens the stipe is very long, as much as about ½ the length of the lamina. This species is generally confused with *L. nudus* in having similar shape and size of the frond but can be distinguished by: (i) thin membranaceous texture with distinct venation as compared to rather fleshy texture and obscure venation in *L. nudus*, (ii) scales with long marginal projections whereas in *L. nudus* these possess almost smooth margin.

Specimens examined: HIMALAYAS: KASHMIR: Lidder Valley (3,300 m), July 1903 (US); Fras Nag (2,700-3,000 m), *Stewart* 23153, July 1947 (US). DALHOUSIE: 2,100 m, *Stewart* 2173, June 1917 (US); Upper Bakrota (2,400 m), *Dhir* 49, Oct. 1962 (PAN). CHAMBA: Kalatop forest, *Lace* 770, July 1895 (CAL); Kearkote, Nilla Valley (4,200 m), *Mackinnon*, Aug. 1906 (CAL); 3,300-3,600 m, *Duthie*, Sept. 1884 (US). SIMLA: Chharabra (2,400 m), *Bir*, Aug. 1960 (PAN); Summer Hill (2,300 m), *Bir* 1520, Aug. 1960 (PAN); *Cwathope*, July 1891 (CAL); Mahsu Hill (2,490 m), *Blanford*, July 1885 (CAL); Huttoo (2,700-3150 m), *Blanford*, July 1885 (CAL); Matroria Hill (3,000 m), *Blanford* in 1828 (CAL); Jako (2,250 m), *Blanford* in 1884 (CAL); Huttoo (2,700 m), *Blanford*, Sept. 1883 (US); Jako Mt. (2,100 m), *Blanford*, Sept. 1886 (US). MUSSOORIE: 1,500 m, *Mackinnon*, Aug. 1900 (CAL); Deoband (2,400 m), *Mackinnon*, Aug. 1904 (CAL); *King* in 1868 (CAL); Dhanauti (2,100-2,400 m), *Stewart* 21195, Aug. 1944 (US); The Park (2,250 m), *Bir*, Sept. 1961 (PAN). DEHRA DUN: *Mackinnon* (CAL); Nag Tibba (1,950 m), *Fleming*, Sept. 1942 (US); Nag Tibba (2,400 m), *Stewart* 21373, Sept. 1944 (US). TEHRI GARHWAL: 1,800 m, Aug. 1879 (CAL); Kharsale, Jumna Valley (2,400-2,700 m), *Datta*, Aug. 1883 (CAL); Ridge above jungle (3,300-3,600 m), *Datta* 432, July 1883 (CAL); *Aitchison* 183, July 1880 (CAL). KUMAON: *Bole*, 5098, Aug. 1962 (BLAT). NEPAL: 3,600 m, *Stainton, Sykes & Williams* 3853, Aug. 1954 (CAL). DARJEELING: Birch Hill (2,100 m), *Bir*, June 1963 (PAN); Tiger Hill, (2,550 m), *Bir*, June 1963 (PAN); Teesta (405-420 m), *Young Husband*, July 1903 (CAL).

Lepisorus nudus (Hook.) Ching in Bull. Fan Mem. Inst. Biol. 4: 83. 1933; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 169. 1964.

Pleopeltis nuda Hook., Exot. Fl. 1: 63. 1823; Alston & Bonner in Candollea 15: 208. 1956; Sledge in Bull. Brit. Mus (nat. Hist.) 2 (5): 135. 1960.

P. linearis Bedd., Handb. Ferns. Brit. India 346. 1883 (pro parte), (non *Polypodium lineare* Thunb., 1784).

P. wightiana Bedd., Ferns South. India 60 t. 180. 1864 (pro parte).

Polypodium nudum (Hook.) Kunze in Linnaea. 23: 281. 1850 (non *P. nudum* Frost f., 1786); Takeda in Notes R. Bot. Gard. Edin. 8: 277. 1915.

P. lineare Clarke in Trans. Linn. Soc. Lond. II. Bot. 1: 558. 1880 (pro parte).

Rhizome minute, thin, 1.5 to 3 mm in diameter, widely creeping and branched, densely scaly; scales dull-brown, ovate-acute, concolorous with almost entire margin, upto 3×1 mm; stipe stout .5-3 cm long, sparsely scaly; frond small, simple, linear, gradually attenuated at the lower end, and acuminate at apex, both sides naked except for few scales on midrib below, 6-25×1-1.2 cm, texture thick, fleshy, light-green to yellowish-brown in colour when dry; venation indistinct, areolae irregular with forked free included veinlets; sori medium to large-sized, medial, golden-brown, when young covered with thin, copious peltate umbrella-shaped paraphyses; spores hyaline or yellow, reniform plano-convex to concavo-convex, exine thin and minutely rugose, 36-64×21-45 μ (Figs. 2, 13-17).

This species is very widely spread throughout the Himalayas and South India between 900-3,600 m altitude. It grows abundantly as an epiphyte or lithophyte.

Distribution: Himalayas, South India, China and Ceylon.

It is not clear whether *Polypodium wightianum* Thw. (Enum. Plant. Zeyl. 394. 1864) belongs here or to *L. amaurolepida* (Sledge) Bir & Trikha.

The closest relatives are *L. amaurolepida* and *L. ussuriensis*. But the three species can be separated on the basis of scale structure. There is a great variation as to the size of the frond depending upon the habitat. When individuals are growing under conditions of desiccation the fronds role from apex downward to stipe and these expand again when there is ample of moisture.

Specimens examined: Isotype: *Pleopeltis nuda* Hook., Exot. Fl. 1: pl. 67. 1823; from India, *Hooker & Thomson* (US 62546).

HIMALAYAS: SIMLA: Chadwick falls (1,600 m), *Blanford* in 1886 (US), KANGRA: 1,500 m, *Koelz* 3944, Jan. 1933 (US); Bashar State (2,100 m), *Koelz* 7401, Nov. 1933 (US). MUSSOORIE: Kempty fall (1,500 m), *Fleming* 20, Aug. 1942 (US); Landour

(1,800 m), *Stewart* 21017, Aug. 1944 (US); 1,800 m, *Devidyal*, Sept. 1956 (PAN); The Park (2,250 m), *Bir*, Sept. 1961 (PAN); Park side (2,100 m), *Bir* 1318, Aug. 1959 (PAN). NAINITAL: 2,100 m, *Datta* 2347, July 1947 (US); 1,800 m, *Duthie*, June 1885 (US). DALHOUSIE: Benikhet (1,600 m), *Dhir* 16, Sept. 1962 (PAN). DARJEELING: *Malhotra*, Sept. 1952 (PAN). SIKKIM: Chungthang (18,00 m), *Bir* 1041, July 1958 (PAN). SOUTH INDIA: MADRAS: Nilgiris from Devax shola (1,500 m), *Subramanyan*, 10597, July 1960 (MH); Near Pariyar dam (900 m), *Subramanyan* 9547, Oct. 1959 (MH); Pariyar Shola, *Bourne* 4961, April 1898 (MH); Gandipeltai (2067 m), *Sebastine* 3305, May 1957 (MH). PALNI HILLS: (1,800 m), *Saldanha* 5077, 5078, March 1960 (BLAT); *Saldanha* 4899, June 1960 (BLAT); Shambaganur, *Sauliere* 157, Sept. 1913 (US). KERALA: Lackhret gap (1657 m), *Sebastine* 17499, Oct. 1963 (MH). BOMBAY: Jumnapath-Matheran, *Irani* 5019, June 1960 (BLAT); Khandala, *Patil* 1100, Sept. 1942 (BLAT); H. S. 40027, Sept. 1941 (BLAT); Mahableshwar, *Santapau* 1309a, Aug. 1957 (BLAT); Lodwick, *Santapau* 13149, Aug. 1951 (BLAT); *Irani* 476, Dec., 1954 (BLAT); *Tankari*, Oct. 1958 (BLAT).

Lepisorus amaurolepida (Sledge) Bir & Trikha in Bir & Vasudeva, Jour. Bombay nat. Hist. Soc. 67: (In press) 1970.

Pleopeltis amaurolepida Sledge in Bull. Brit. Mus. (nat. Hist.) 2(5): 136. 1960.

Polypodium gladiatum Wall., List n. 279. 1828, *nomen nudum* (non *P. gladiatum* Kunze 1834).

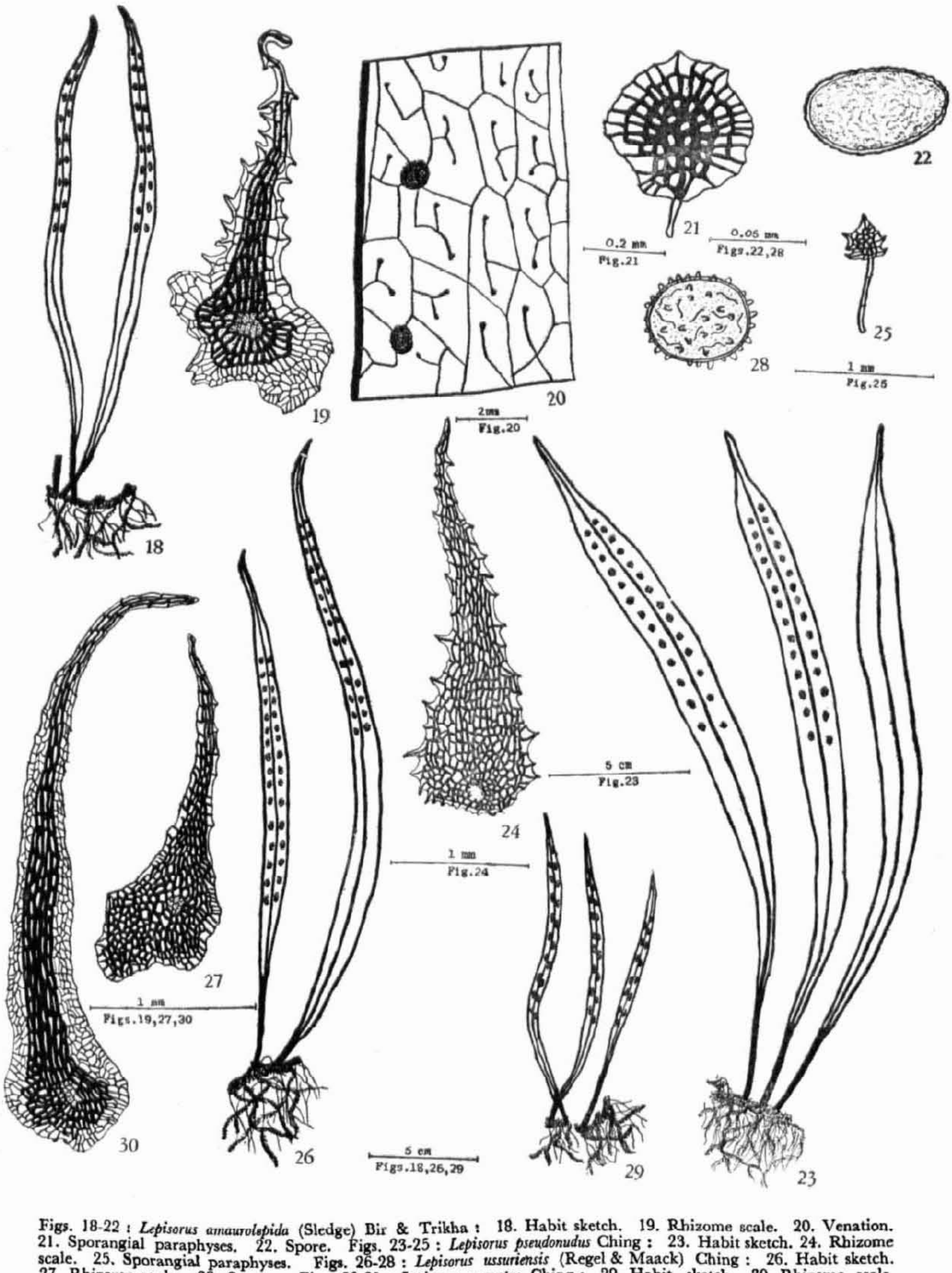
Rhizome thin, 1.5-3 mm in diameter, widely creeping and branched, densely scaly throughout; scales dark-brown, bicolorous, sortly acuminate firm or orbicular, peltate, margin dentate, 2-3 mm long, 1-1.5 mm wide at base, Clathrate, cells with heavily thickened walls along the centre of the scale, cell cavities obscured by blackish-brown colouration; stipes closely placed, about .5-1 cm apart, short, 1-3 cm long, naked; fronds linear-lanceolate, gradually attenuated downwards, apex long-acuminate or rarely abruptly shortened and acute, 6-25 cm long × .5-2 cm wide; texture fleshy; colour light-green or brown; both surfaces glabrous except for few scales on underside along midrib; veins indistinct, areolae in 2-3 series, irregular with free included veinlets; sori medial, medium to large-sized, golden-brown, when young covered with peltate, sporangial paraphyses having thickened and coloured cell walls: spores yellow, plano-convex to concavo-convex and sometimes reniform, exine thick, 48-58 × 29-42 μ (Figs. 18-22).

It is most widely met with in South India on Palni and Nilgiri Hills between 1,500-2,200 m altitude and also recorded from Mahableshwar, Coorg, Coimbatore and Kerala State. Further, it is frequently met with at Panchmaree (Madhya Pradesh) and occasionally throughout the Himalayas.

Distribution: Himalayas, Central India, South India and Ceylon.

The habitat is exactly like *L. nudus* (=*Pleopeltis wightiana* Bedd.) or *Polypodium wightianum* Thw. under which name it has largely been placed. It is found with equal frequency on rocks or tree trunks. The chief difference from *L. nudus* is in the structure and shape of scales otherwise in general appearance, size and texture of frond, both the species exactly resemble each other. In *L. amaurolepida* the scales are bicolourous and shortly acuminate with firm, orbicular peltate base and their margin is prominently dentate whereas in *L. nudus* scales are concolorous, almost entire-margined, ovate and acute.

Specimens examined: HIMALAYAS: DEHRA DUN: 720 m, *Hope* in 1880 (US). TEHRI GARHWAL: Jaucco valley (1,800-2,100 m), *Mathur*, Oct. 1881 (CAL). KUMAON: Jathana (1,590 m), *Starchey* & *Winterbottom*, (CAL). DARJEELING: *Mehra* 14, (US); Lebong forest, *Bir* 904, Aug. 1957 (PAN). CENTRAL INDIA: Panchmaree (900 m), *Morris* in 1881 (CAL). SOUTH INDIA: MADRAS: *Gamble* 13889, March 1884 (CAL); Kantha Parai (900 m), *Henry* & *Chandrabose* 19842, July 1964 (MH); Sholaiyar, submergible area (1,040 m), *Sebastine* 16660, July, 1963 (MH). NILGIRIS: Ralliahdam (2,100-2,400 m), *Saldanha* 1202, May 1954 (BLAT); Mahableshwar, *Luke*, Oct. 1890 (CAL); *Foulke* 30, March 1803 (CAL); *Blanford*, (CAL); Ooty (2,100 m), *Gamble* 12507, Sept. 1883 (CAL); *Thakur*, (CAL); 2,250 m, *Clarke* 11220, March 1870 (CAL); Coorg, *Walker*, March 1898 (CAL); *Gough* (CAL); Devicolani (1,800 m), *Meebold* 1,3500, Dec. 1910 (CAL); Belloji scholas (1,500 m), *Fischer*, Aug. 1905 (CAL); Herb. *Wight*, 3165 (CAL). KODAIKANAL: Pamber shola (1,950 m), *Levinge*, April 1883 (CAL); 2,040 m, *Fischer* 3057, Sept. 1911 (CAL); 2,100 m, *Gamble* 117227, April 1816 (US); Moir point (2,002-2,100 m), *Bir*, June 1962 (PAN). KERALA: Vandipariyar. *Saldanha* 7966, Nov. 1961 (BLAT).



Figs. 18-22 : *Lepisorus amaurolepida* (Sledge) Bir & Trikha : 18. Habit sketch. 19. Rhizome scale. 20. Venation. 21. Sporangial paraphyses. 22. Spore. Figs. 23-25 : *Lepisorus pseudonudus* Ching : 23. Habit sketch. 24. Rhizome scale. 25. Sporangial paraphyses. Figs. 26-28 : *Lepisorus ussuriensis* (Regel & Maack) Ching : 26. Habit sketch. 27. Rhizome scale. 28. Spore. Figs. 29-30 : *Lepisorus angustus* Ching : 29. Habit sketch. 30. Rhizome scale.

Lepisorus pseudonudus Ching in Bull. Fan Mem. Inst. Biol. 4: 83. 1933; Ic. Fil. Sin. 2: t. 60, 1934.

Pleopeltis pseudonuda (Ching) Panigr. & Patn. in Curr. Sci. 34: 127-128. 1965.

Rhizome widely creeping, densely scaly; scales ovate-lanceolate, acuminate with rounded base, margin with protruding teeth, concolorous, fuscous, clathrate with large, clear uniform luminae; frond about 1 cm apart, 20-25 cm long, about 1.5 cm broad, elongate, oblanceolate, gradually attenuate to a short but distinct stipe, apex caudato-acuminate, quite glabrous on both sides; texture subcoriaceous; venation completely hidden; sori medium-sized, rounded, medial, extending half way downward (Figs. 23-25).

The cytology of this species ($2n=39$) has been worked out from Assam by Panigrahi and Patnaik (1961). It has been collected from Khasi Hills, Tirap F.D. and Mameng F.D. of N.E.F.A. by the same authors (*Panigrahi & Patnaik,* 1965). Since the specimens of this species were not available to us for examination, the above description is based on Ching (1934).

This fern resembles very closely *L. nudus* in general habit but can be separated mainly on the basis of fuscous, lanceolate, long-acuminate scales having dentate margin and clear, uniform luminae. The apex of the lamina is rather suddenly caudato-acuminate. The sori are characteristically medial in position.

Lepisorus ussuriensis (Regel & Maack) Ching in Bull. Fan Mém. Inst. Biol. 4 : 91. 1933; Ic. Fil. Sin. 2. Pl. 74, 1934, cum syn.

Pleopeltis ussuriensis Regel & Maack in Mém Acad. Sci., Petersle. VII. 4: 40. 175. 1861.

Polypodium lineare var. *ussuriense* C. Chr. Index Fil. 572. 1906.

Rhizome thin, but hard, widely creeping and branched, densely scaly, scales being deciduous from the older part; scales appressed, ovate-acuminate, black brown, rarely margin slightly dentate, cells uniformly thickened throughout except for few cells in the middle which have opaque luminae and dark-coloured cell walls; fronds about .5 cm apart. narrowly linear-lanceolate, with clear stipe which may be from 1.5-4 cm long and sparsely scaly, apex acuminate, long attenuate; texture coriaceous; both surfaces glabrous except for few scales in the lower region of the midrib on undersurface; colour greenish-brown; venation obscure; sori far apart, round, medial, and small to medium-sized; paraphyses protect the young sori, these have uniformly thickened cells; spores yellow, almost rounded or globose to oval or plano-convex, exine tuberculated with blunt projections, $41\text{-}57 \times 32\text{-}48\mu$ (In some specimens irregular and different sized) (Figs. 26-28).

This species has got the same distributional range in the Himalayas as *L. nudus.* It was collected from various localities around Simla (between 2,300 to 2,550 m altitude), Western Himalayas and Darjeeling (Lebong, 1,650 m) in the Eastern part. In some specimens the spores are irregular and different sized.

Distribution: Himalayas, China, Korea, Japan and Eastern Siberia.

In its general aspect the present species very much resembles *L. nudus* and was hitherto placed under that species However, it remarkably differs from *L. nudus* in possessing heavily tuberculated spores and in this character it resembles *L. thunbergianus.* It has been separated from *L. thunbergianus* because the scales of *L. ussuriensis* do not possess the hyaline margin of the base and all the cells are uniformly thickened.

Specimens examined: HIMALAYAS: SIMLA: Shali peak (2,300 m), *Bir,* Sept. 1960 (PAN); Narkanda (2,550 m), *Bir,* Aug. 1961 (PAN); Chharabra (2,400 m), *Bir,* Aug. 1960 (PAN). MUSSOORIE: Jabberkhet (2,100 m), *Stewart* 21407, Aug. 1944 (US). DARJEELING: Lebong forest (1,650 m), *Malhotra,* Aug. 1954 (PAN).

Lepisorus angustus Ching in Bull. Fan Mem. Inst. Biol. 4: 86. 1933; Ic. Fil. Sin. 2: Pl. 73. 1934.

Polypodium lineare var. *thunbergianum* f. *caudato-attenuata.* Takeda in Noes R. Bot. Gard. Edinb. 8: 269. 1915.

P. caudato-attenuatum (Takeda) C. Chr., Ind. Suppl. III. 146. 1934.

Pleopeltis caudato-attenuata (Takeda) Panigr. & Patn. in Curr. Sci. 34: 127-128. 1965.

Lepisorus thunbergianus (Kaulf.) Ching var. *angustus* (Ching) Kurata in Sci. Report Yokosuka City Mus. No. 11, p. 39. 1965.

Rhizome widely creeping, medium-sized, 2-4 mm in diameter, densely scaly throughout; scales atratous, linear-subulate with broad ovate base, rigid, 2-3 mm long, about 1 mm wide at base, opaque in the middle, margin erose, hyaline with clear elongate luminae; fronds distant, 5.-1.5 cm apart, slender, narrowly linear, caudato-attenuate to the apex, 6-20 cm long, 3-8 mm wide, margin revolute; texture subcoriaceous; colour pale-green; venation obscure; sori oblong or quite elongated, close to each other, placed between midrib and the margin, at maturity almost filling the entire surface, in young stage protected by a dense covering of peltate paraphyses with slightly hyaline margin; sporangia intermixed with simple hair-like paraphyses; spores hyaline to light-yellow, reniform to plano-convex or oval-oblong, exine somewhat thickened and verrucose-granulated, 51 × 67 × 35-45 μ (Figs. 29-32).

It is epiphytically met with in North Sikkim (Lachen, about 2,700 m), but not common. Also recorded from Tirap F.D., N.E.F.A. (*Panigrahi* 14956) by Panigrahi & Patnaik (1965).

Distribution: Eastern Himalayas, Japan and China.

This species had long been united with *Polypodium lineare* or more recently placed under *Lepisorus nudus*. A detailed examination of scales and spore structure has shown that it is quite different from *Lepisorus nudus* or its allied species *L. amaurolepida*. The close affinity of this fern is with *L. thunbergianus* with which it shares the same structure of the scales (atratous and rigid) but differs in having (i) extra-ordinary slender habit, (ii) rhizome scales in the centre are more blackish than *L. thunbergianus* and the cells of the scales are somewhat smaller than those of the other species, (iii) long attenuated-caudate apex of the frond, (iv) elongated sori, and finally (v) in having somewhat thickened and granulated-verrucose exine of the spores.

Specimens examined: HIMALAYAS: KANGRA: 1,500 m, *Koelz* 7534, (US). SIKKIM: Lachen (2,640 m), *Bir* 1052, July 1958 (PAN); Lachen (2,700 m), *Panthing*, May 1885 (CAL).

Lepisorus thunbergianus (Kaulf.) Ching in Bull. Fan Mém. Inst. Biol: 4: 88. 1933; Ic. Fil. Sin. 2: Pl. 76. 1934, cum syn.

Pleopeltis thunbergiana Kaulf., Wesen. d. Farrnke. 113, 1827.

Polypodium lineare Thunb., Fl. Jap. 335. 1784 (non Burm. 1768, nec. Houtt., 1783); Hook. & Bak. Syn. Fil. ed. *ii* 354. 1874 (pro parte); Clarke in Trans. Linn. Soc. Lond. II. Bot. 1: 558, 1880 (pro parte); C. Chr., Index Fil. 540. 1906 (pro parte).

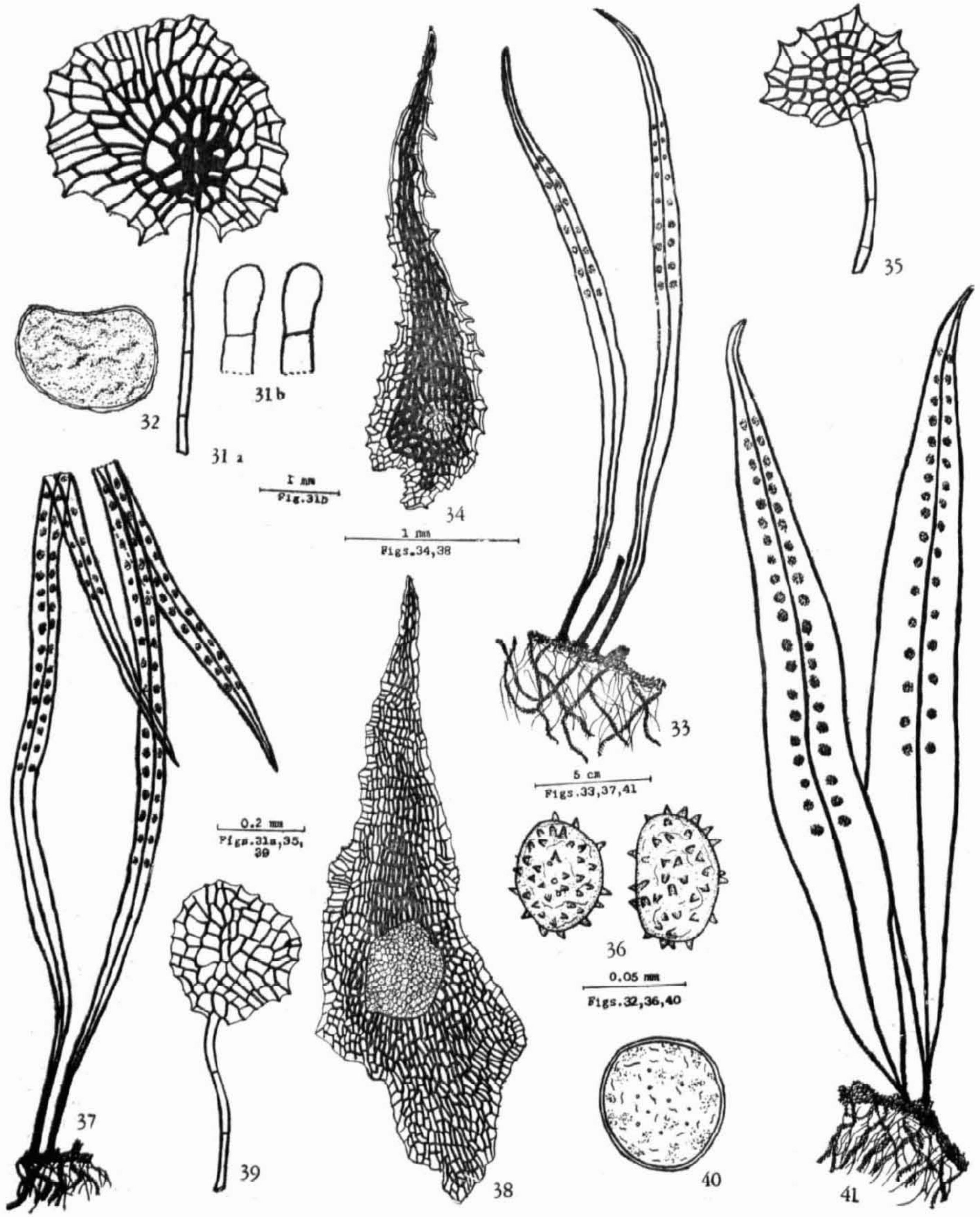
Pleopeltis linearis Moore, Index Fil. 346, 1862 (pro parte); Bedd., Handb. Ferns Brit. Ind. 346. 1883 (pro parte).

Rhizome medium-sized, widely creeping, branched, with tufts of roots on underside, 3-6 mm in diameter, densely scaly; scales linear or lanceolate-subulate, with broad ovate base and acute tip, rigid, black, 2-5 mm long, 1-1.5 mm wide, dense and opaque in the middle, hyaline and clear at the broad margin of the base with clear elongate luminae, margin dentate; fronds rather approximate, about .5 cm apart, linear-lanceolate, without long acuminate apex, 12-25 cm long, 1-1.5 cm wide in the middle (widest in the middle), gradually attenuated below to a short stipe which is generally about .5 to 1 cm long, rarely 2 cm long and scaly; texture coriaceous, both surfaces glabrous except for the midrib which is sparsely scaly underneath especially towards the base of the frond; colour light-green to dark-brown on drying; venation obscure; sori more near the midrib than the margin, rounded, large at maturity, close to each other; paraphyses closely protecting the young sori but deciduous at maturity; spores yellowish brown, plano-convex to concavo-convex, exine thick and heavily tuberculated, ca. 42-57 × 32-45 μ (Figs. 33-36).

Occasionally met with as an epiphyte or lithophyte in Darjeeling-Sidrapong 1,200 m, Eastern Himalayas and near Simla-Huttoo Peak, 3,000 m and Almora, 1500 m (cf. Khare, 1965) in the Western part. Rao Rolla (1963) has reported it to be very common on moist rocks and tree trunks between Toong to Chungthang and Lachung towards Yumthang in North Sikkim.

Distribution: Himalayas, China, Japan, Korea, Indo China, Formosa and Phillipines.

The type of this species comes from Japan. According to Kurata (1965) the typical form has short rhizomes with close fronds. Specimens of *Polypodium lineare* from various regions have often been referred to this species and thus making its distributional range quite doubtful. Previously, Mehra & Bir (1964) had reported that *L. thunbergianus* is not met within India but on scrutiny of herbarium material placed under *Polypodium lineare* or *L. nudus* it has been noted that this species grows throughout the Himalayas and is probably sympatric in distribution with *L. nudus* from which it can be distinguished primarily on the basis of scale structure. In case of present species the scales are subulate-linear or lanceolate, long accuminate, ciliate-dentate and opaque as compared



Figs. 31-32 : *Lepisorus angustus* Ching : 31a. Sporangial paraphyses. 31b. Hair-like sporangial paraphyses. 32. Spore. Figs. 33-36 : *Lepisorus thunbergianus* (Kaulf.) Ching : 33. Habit sketch. 34. Rhizome scale. 35. Sporangial paraphyses. 36. Spore : Figs. 37-40 : *Lepisorus contortus* Ching : 37. Habit sketch. 38. Rhizome scale. 39. Sporangial paraphyses. 40. Spore. Fig. 41 : *Lepisorus kashyapii* (Mehra) Mehra : 41. Habit sketch.

to ovate, acute, entire, and somewhat brownish scales in *L. nudus*. Spores are also different in both the species, *L. thunbergianus* possesses tuberculated ones while *L. nudus* smooth or minutely rugose ones. The morphological and anatomical details of this species together with *L. excavatus* have been worked out by Khare (1965).

Specimens examined: HIMALAYAS: SIMLA: Huttoo Peak (3000 m), Bir, Aug. 1960 (PAN). DARJEELING: Sidrapong (1,200 m), *Bir & Malhotra* 739, July 1957 (PAN).

Lepisorus contortus (Christ) Ching in Bull. Fan. Mém. Inst. Biol. 4: 90. 1933; Ic. Fil. Sin. 2: Pl. 75. 1934, cum syn.

Polypodium contortum Christ in Bot. Gaz. 51: 347. 1911.

P. lineare Thunb. var. *contortum* Christ in Nuovo Giorn. Bot. Soc. Ital. n.s. 4 : 98. Pl. I. f. 3. 1897.

Pleopeltis contorta (Christ) Alston & Bonner in Candollea 15: 209. 1956.

Rhizome woody, medium-sized, widely creeping, 3-6 mm in diameter, densely scaly throughout, scales deciduous, appressed, ovate-acuminate, rufo-brown, upto 4 mm long, 1-1·5 mm wide, margin slightly dentate, luminae generally elongate and clear except for those in the middle part of the scales, which are opaque and darker in colour; fronds distant, upto 5 cm apart, 25-40 cm long, 1-1·5 cm wide, linear elongate, base gradually decurrent on the stipe for a greater part; stipes 2-5 cm long, naked; texture coriaceous, both surfaces glabrous, midrib prominent; colour pale-green; venation obscure; sori oblong, sub-medial or medial, at maturity somewhat ovate, paraphyses deciduous at quite an early stage; spores light-yellow, oblong, concavo-convex or oval, exine thin and smooth (aborted in some specimens) 48-67 × 32-48 μ (Figs. 37-40).

It is occasionally met with in North Sikkim and Nepal (Eastern Himalayas) between 1,500-3,370 m and often grows epiphytically.

Distribution : Himalayas, China (North & West) and Tibet.

It is a fairly large-sized species of the *Polypodium lineare* complex but can be separated on the basis of scales which hardly resemble any other species. With *L. nudus* it can be confused in having somewhat similar laminae and spore structure. From *L. thunbergianus* and *L. angustus* it is separable on the basis of ovate-acuminate, rufo-brown scales with large clear luminae except for the centre and very much distantly placed stipes.

Specimens examined: HIMALAYAS: KANGRA: Parbati valley, *Koelz* 4844, June 1933 (US). SIKKIM: Chungthang (1,800 m), *Bir* 1034, July 1958 (PAN.)

Lepisorus kashyapii (Mehra) Mehra in Bir, Res. Bull. Panjab Univ. (n.s.) 13: 23. 1962; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 168. 1964.

Polypodium kashyapii Mehra in Ferns of Mussoorie, Panjab Univ. Publ. 24. Fig. 5. 1939.

Pleopeltis kashyapii (Mehra) Alston & Bonner in Candollea 15: 208. 1956.

Rhizome widely creeping, thick, 4-8 mm in diameter, densely to sparsely scaly; scales linear to lanceolate, dark-brown, peltate, clathrate, with prominent marginal projections, 2-7 mm long and 1-1·5 mm wide; stipes straw-coloured, 2-4 cm long; fronds simple, broadly lanceolate, 20-40 cm long and 2·5-4 cm wide, apex acute; gradually attenuate to a short stipe; texture thick, sub-coriaceous; colour bright-brown on drying; ovate-acuminate scales with long protruding marginal projections present along the midrib on under surface; venation inconspicuous, areolae irregular with forked free veinlets; sori large, more or less deeply sunk, rounded, nearer to the midrib than to the margin; annulus cells 12-15; spores reniform or oval, brown and minutely verrucose *ca.* 42-60 × 30-50 μ (Figs. 41-45).

Occasionally met with throughout the Himalayas between 1,500-2,400 m altitude. It often grows on middle portions of tree trunks.

Distribution: Himalayas.

This species is closely allied to *L. excavatus* with which it was previously grouped, and often intermediate forms between the two species are met with. The two species hybridize freely in nature and large number of specimens with abortive spores were collected. The typical *L. kashyapii* differs from *L. excavatus* in the following characters:

(*i*) Rhizome creeping superficially on the substratum giving out stiff almost perpendicular roots.

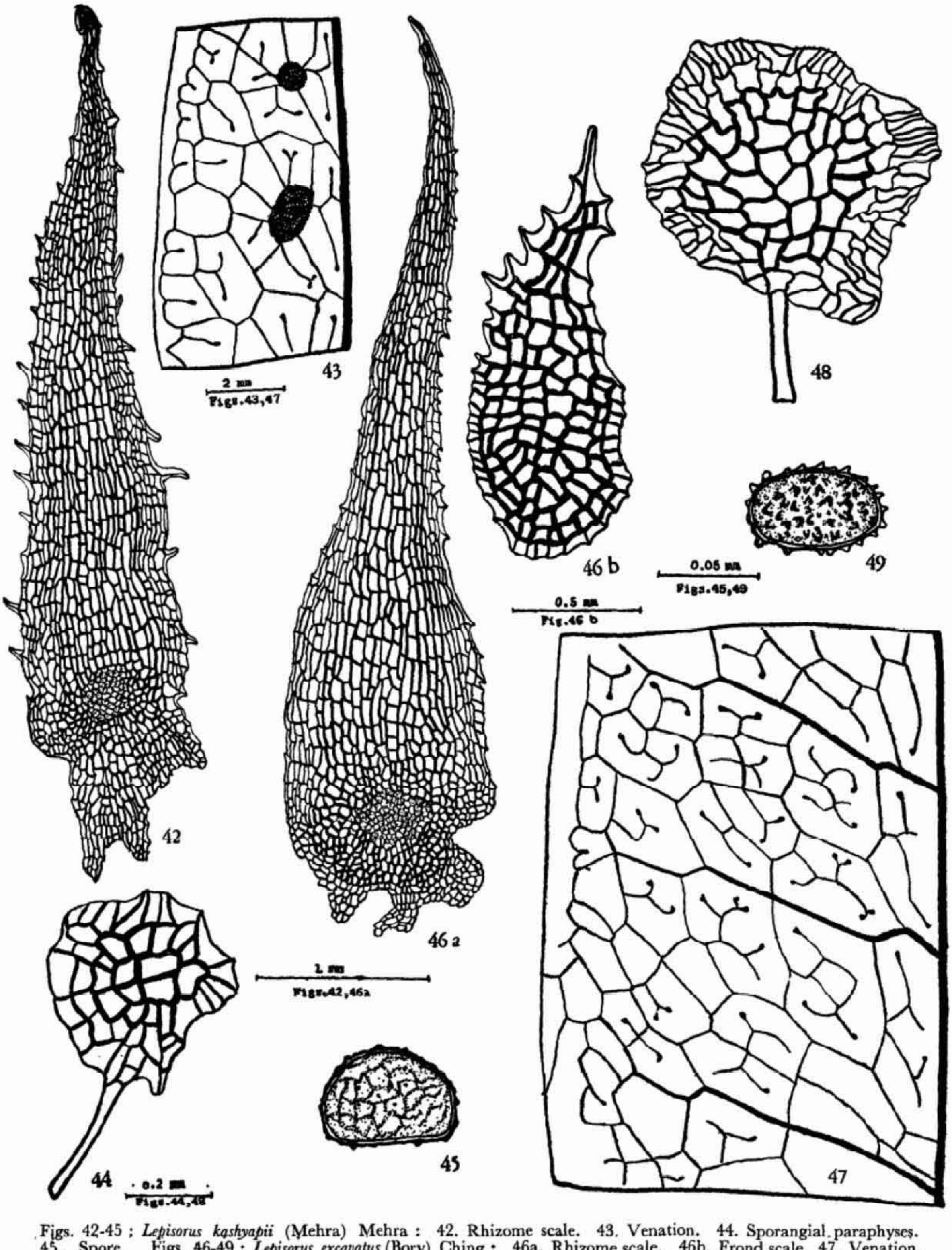
(*ii*) Fronds turn bright brown on drying.

(*iii*) The scales on the rhizome apex as well as on the under surface of the frond are hair-pointed and have prominent marginal projections.

(*iv*) Lateral veins practically inconspicuous.

(*v*) The under surface of the frond is more scaly as compared to *L. excavatus*.

Specimens examined: HIMALAYAS: SIMLA: *En*



Figs. 42-45 : *Lepisorus kashyapii* (Mehra) Mehra : 42. Rhizome scale. 43. Venation. 44. Sporangial paraphyses. 45. Spore. Figs. 46-49 : *Lepisorus excavatus* (Bory) Ching : 46a. Rhizome scale. 46b. Frond scale, 47. Venation, 48. Sporangial paraphyses. 49. Spore.

route Shali peak (2,400 m), *Bir* 1046, Sept. 1960 (PAN); Sanjouli (2,100 m), *Bir,* Aug. 1960 (PAN); Chharabra (2,400 m), *Bir,* Aug. 1960 (PAN); Sanjouli, *Bir,* Sept. 1958 (PAN). MUSSOORIE: 1,800 m, *Bir* 1343, Aug. 1959 (PAN); Jabber Khet (2,100 m), *Stewart* 14941, Aug. 1935 (US); Nag Tiba, (2,400 m), *Fleming* 82, Sept. 1947 (US). NAINITAL: 1,800-2,100 m, *Datta* 23475, July 1947 (US). DARJEELING: Senchal forest (1,500 m), *Malhotra* 744, July 1957 (PAN); Manibhanjang-Tonglu Road (2,400 m), *Bir* 774, July 1957 (PAN); Manibhanjang-Tonglu Road (2,000 m), *Bir,* July 1957 (PAN). SIKKIM: Lachen (2,200 m), *Bir* 1051, Sept. 1958 (PAN); *Thomson* (US). NEPAL: Dhothbas (3,000 m), *polunin, Sykes* and *Williams* 5568, Oct. 1952 (US); Garpung Khola (3,000 m), *Polunin, Sykes* and *Williams* 5410, Sept. 1952 (US).

Lepisorus excavatus (Bory) Ching in Bull. Fan Mén. Inst. Biol. 4 : 68, 1933; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15 : 168. 1964.

Polypodium excavatum Bory in Willd. Spec. 5: 158, 1810.

P. lineare Clarke in Trans. Linn. Soc. Lond. II. Bot. 1 : 558, 1880 (pro parte).

P. simplex Sw., 1801; Blanford in Jour. Asiatic Soc. Bengal. 57 : 313. Pl. 20. 1888.

Pleopeltis simplex Bedd., Handb. Ferns Brit. India, 347. 1883.

P. excavata Sledge in Bull. Brit. Mus. (Nat. Hist.) (5) : 138. 1960.

Rhizome thick, 4-9 mm in diameter, widely creeping, woody, in some specimens rhizome compressed; scales lanceolate, apex acuminate, dull-brown, clathrate, with slightly erosed margin, 3-7 mm long, 1-1.5 mm broad; stipes .5-4 cm long, yellowish-green; fronds simple, ovate-lanceolate, 14-46 cm long, 2-4 cm broad, decurrent at the base, apex acute, not caudato-attenuate; texture stiff, membranaceous: colour pale or greenish on drying; laminae scaly on the under surface, yellowish-brown, scales thick from the centre and deciduous; venation prominent; sori large, nearer to the midrib, deeply sunk forming pustules on the upper side of the frond; sporangial paraphyses umbrella-shaped, thick in the centre, with rather short stalk; spores light-brown, more or less tuberculate, oval to reniform, 48-69 × 34-45 μ (Figs. 3, 46-49).

It is very frequently met within the Western Himalayas usually as an epiphyte between 1,500-2,100 m altitude or little above but becomes comparatively rarer as one moves Eastwards to Darjeeling.

Distribution: Himalayas, South India, Japan, Tropical Africa and Madagascar Islands.

The midrib on the undersurface is scaly throughout, scales being often deciduous. The outline of frond is characteristically ovate-lanceolate-acute but not caudato-attenuate. The frond is the broadest in the lower ¼ portion.

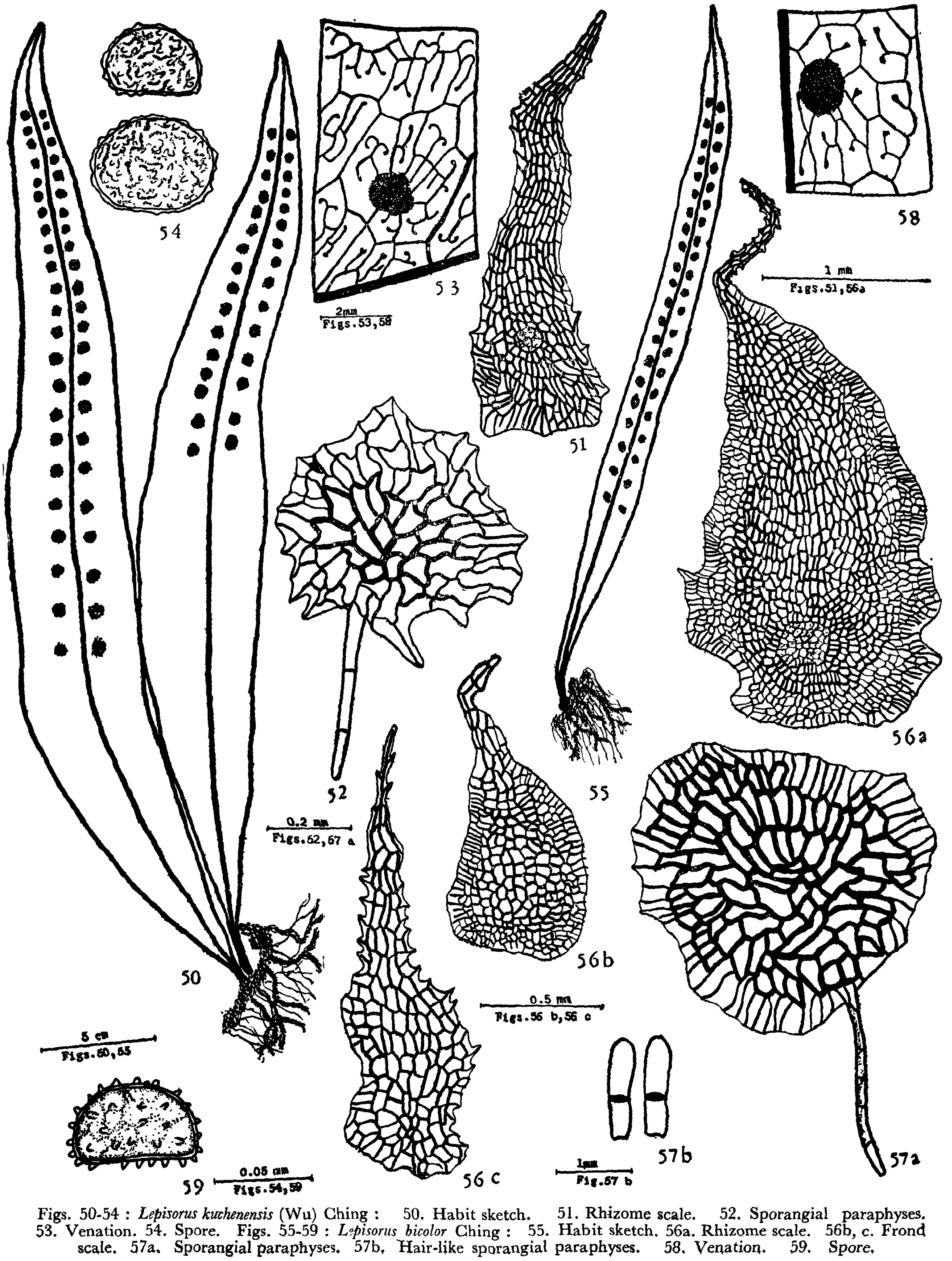
Specimens examined: Isotype: *Polypodium excavatum* Bory [=*Polypodium sesquipedale* Wall. ex. Mett. (Abhandl. Senckneb. Naturf. Ges. 2: 91. 1887) from Nepal, *Wallich,* 275 in 1821 (US 1277832).

HIMALAYAS: SIMLA: Summer Hill (2,100 m), *Bir* 49, Aug. 1960 (PAN). MUSSOORIE: (1,800 m), *Devi Dyal,* Sept. 1956 (PAN); Magra (1,650 m), *Bir* 1347, Aug. 1959 (PAN); Camel's back road (1,800 m), *Malhotra,* Aug. 1952 (PAN). DALHOUSIE: Moti Tibba (2,400 m), *Dhir* 5, Aug. 1962 (PAN). DARJEELING: Lebong (1,650 m), *Bir* 25, Aug. 1956 (PAN); Senchal forest (2,500 m), *Bir* 745-A, July 1957 (PAN).

Lepisorus kuchenensis (Wu) Ching in Bull. Fan Mém. Inst. Biol. 4: 69. 1933; Ic. Fil. Sin. 2: Pl. 64. 1934; Mehra & Bir in Res. Bull. Panjab Univ. (n.s.) 15: 168. 1964.

Polypodium kuchenensis Wu in Wu *et al.*, Polypod. Yaoshan. 276, t. 129. 1932.

Rhizome thick, woody, 5-8 mm wide, widely creeping, densely scaly; scales of variable shape, oblong-ovate, or ovate-lanceolate or lanceolate-acuminate, thin, imbricate, yellowish or pale-brown, hyaline near edges, upto 5 mm long, 2-3 mm wide, margin undulate, erosed or distantly minutely toothed; stipes thick, short 1-3 cm long, densely scaly at base; fronds far-apart, broadly lanceolate, 18-38 cm long, 3-8 cm wide at middle, apex acuminate, gradually attenuate to a decurrent base or suddenly cuneate, scarious, margin entire or slightly wavy down below; texture herbaceous; colour dull brown; naked, except few scales beneath on the lower part of midrib; venation anastomosing, main veins patent, more or less distinct but not reaching the margin, areolae upto 6 between margin and midrib with simple or branched free included veinlets with clavate apices; sori large, round or subglobose, more near the midrib than the margin and in one regular row on each side, ⅓-¾ of the frond fertile; when young protected by umbrella-



Figs. 50-54 : *Lepisorus kuchenensis* (Wu) Ching : 50. Habit sketch. 51. Rhizome scale. 52. Sporangial paraphyses. 53. Venation. 54. Spore. Figs. 55-59 : *Lepisorus bicolor* Ching : 55. Habit sketch. 56a. Rhizome scale. 56b, c. Frond scale. 57a. Sporangial paraphyses. 57b. Hair-like sporangial paraphyses. 58. Venation. 59. Spore.

shaped paraphyses; spores oval to reniform, pale-yellow or hyaline, exine thick and somewhat undulated or slightly tuberculated, 42-58 × 29-48 μ (Figs. 50-54).

It is met with generally as an epiphyte in Darjeeling district and Sikkim State in the Eastern Himalayas between 2,100-2,400 m altitude. Also recorded from Nepal (Kathmandu).

Distribution: Himalayas and China (Yaoshan State).

It is closely allied to *L. excavatus* but chiefly differs in having:

(*i*) Thin herbaceous fronds upto 8 cm wide in the middle and usually brown in colour when dry.

(*ii*) Large (upto 7 × 11 mm) round or oblong, elongated, submedial, superficial sori which are hardly punctate on the upper surface.

Specimens examined: EASTERN HIMALAYAS: DARJEELING: Tonglu Road (2,700 m), *Bir*, Aug. 1956 (PAN); Malhotra, Aug. 1954 (PAN). SIKKIM: Senchal (2,550 m), *Levinge*, June 1882 (CAL). KUMAUN: Kalimundi, (2,100 m), *Strachey* and *Winterbottom* (CAL).

Lepisorus bicolor Ching in Bull. Fan Mém. Inst. Biol. 4:66. 1933; Ic. Fil. Sin. 2: Pl. 65, 1934.

Polypodium excavatum var. *bicolor* Takeda in Notes R. Bot. Gard. Edinb. 8: 280. 1915; C. Chr., in Contr. U.S. nat. Herb. 26: 319. 1931.

Rhizome thick, 4-8 mm in diameter, epigaeous, densely imbricatingly scaly, possessing tuft of roots on the underside; scales fuscous-brown, clathrate, adpressed, broadly ovate, long-acuminate, with uneven margin, bicolorous, dark in the middle and hyaline on the edges, luminae in the central region small and narrow as compared to clear, large ones on the margin having flexuous thin cell walls, 2-4 mm long, 1-1.5 mm broad; stipes distinct, stramineous, 1.5-4 cm long, closely placed, about 1-2 cm apart, covered with the same type of scales as on rhizome; frond about 12-35 cm long, 1.3-2.0 cm broad, linear lanceolate (broadest in the lower portion), gradually attenuate at both the ends, margin entire, midrib below covered with deciduous, linear-lanceolate or ovate-acuminate, discolorous scales with erosed margin; texture chartaceous; colour light to brownish-green; veins obscure, but distinct against light, main lateral veins not prominent, areolae small and with simple or forked free included veinlets; sori oblong or round, brown, nearer to the midrib than to the margin, confluent towards apex at maturity, sporangial paraphyses umbrella-shaped, clathrate, discolorous (also present alongwith are two-celled hair-like simple paraphyses) annulus cells 14-18; spores light-yellow, oval-oblong, reniform or plano-convex to cancavo-convex, exine thick and papillate and bluntly tuberculated, 32-61 × 29-42 μ (Figs. 55-59).

According to Ching (1934) it is recorded from Kumaun (*Strachey* and *Winterbottom*) and Darjeeling (*Griffith*). Also met with in Nepal (cf. specimens cited below). It grows on boulders in shade.

Distribution: Himalayas, Burma and China.

The sepcimens of this species have largely been placed under *Polypodium excavatum* (=*Lepisorus excavatus*) of authors on North Indian ferns. Even Christensen (1934) revised his earlier opinion (*Christensen*, 1931) of according it a varietal status under *P. excavatum* and merged it completely with that. The Himalayan samples of *L. excavatus* differ from the present species primarily in scale structure. *L. bicolor* possesses not only bicolorous and smaller scales but also of an entirely different outline from those in *L. excavatus*.

Specimens examined: HIMALAYAS: NEPAL: Mahrigaon (3,450 m), *Polunin, Sykes* & *Williams* 203, July 1952 (US); between Munigaon and Chutta, S.E. of Jumla (2,850 m), *Polunin, Sykes* & *Williams* 4894, July 1952 (US).

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